

## **InGaN/GaN blue light emitter grown on Si(111) using an AlAs seed layer**

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We present a simple InGaN/GaN quantum well electroluminescence structure grown by LP-MOCVD on n-type Si (111). In contrast to sapphire and SiC substrates, Si offers the advantage of lower cost, availability of large scale substrates, and compared to sapphire substrate much easier processing of light emitters. Thus, the growth of GaN on Si substrates is a promising way for the low cost production of GaN based LEDs [1, 2]. However, the main disadvantage of Si is the high lattice and thermal mismatch leading to the formation of cracks when exceeding a layer thickness of approximately 1  $\mu\text{m}$ .

A prerequisite for the MOCVD growth of GaN on Si is to avoid the direct contact of Ga with the Si substrate. Otherwise no planar GaN growth due to meltback etching of the Si substrate is possible [3]. We overcome this problem by using a nitrided low temperature AlAs seed layer of approximately 60 nm in thickness [4] which was deposited prior to the growth of the light emitting structure. The structure consists of a 2  $\mu\text{m}$  n-type GaN:Si buffer layer followed by an undoped InGaN quantum well and 600 nm of p-type GaN:Mg for the top contact. Despite the formation of cracks we could successfully make light emitters using a very simple photolithographic process, evaporating 10 nm of Pt as a transparent front contact and Al as backside contact on the n-type Si substrate.

In cathodoluminescence measurements a shift of the GaN emission peak at 5 K from 349 nm to 359 nm is induced by tensile strain of the layer. Additionally an emission around 400 and 460 nm with the emission in the near UV being approximately 3 times stronger than around 460 nm is observed. The emission around 400 nm is most likely due to the Mg doped p-type top layer. The emission around 460 nm originates at the InGaN quantum well and appears mostly at the edges of the cracks due to the limited penetration depth of the electron beam.

The electroluminescence signal on Si is compared to the reference sample at room temperature. Here the emission wavelength is 434 nm for the structure on sapphire and shifts to 444 nm for the structure on Si (Fig. 1). At a current of 20 mA the integral intensity in the sapphire based emitter is about 30 times stronger than for the Si-based. This difference in intensity is partly due to the p-side contact wire on the Si based device since it covers part of the diode (Fig. 2). Additionally absorption of the emitted light in the Si substrate takes place while the reference sample was measured from the back through

the sapphire substrate. Despite the lower intensity of the electroluminescence structure on Si the emission is well visible with the naked eye at daylight.

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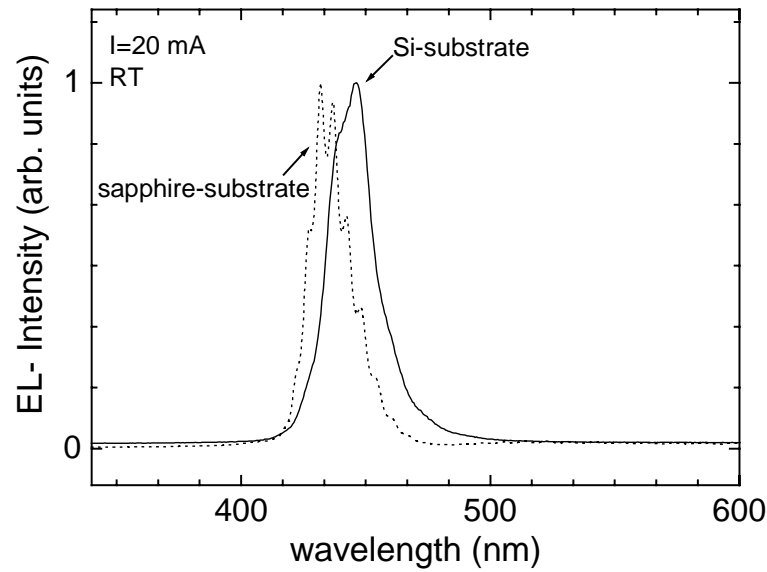


Fig. 1 Electroluminescence spectrum of a simple InGaN/GaN quantum well grown on sapphire (dotted line) and of an identical structure grown on Si

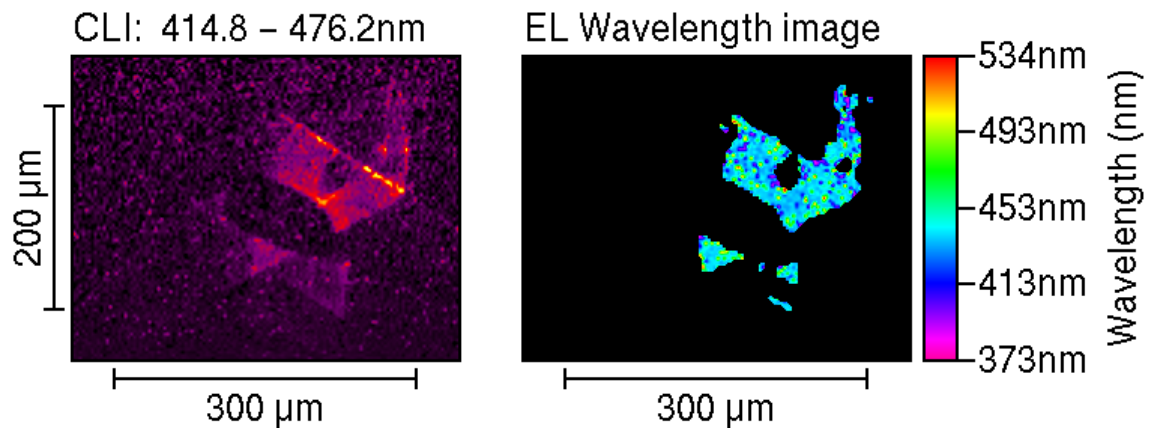


Fig. 2 Electroluminescence wavelength mapping of the test structure on Si: The intensity map (left) shows the strongest emission from the edge of a crack and of the top contact wire which is the dark spot in the middle. The wavelength image (right) shows a homogenous distribution in the peak wavelength.